ANALIZY I OPRACOWANIA

# DEEP DETERMINANTS OF ECONOMIC GROWTH – EMPIRICAL VERIFICATION WITH PANEL DATA MODELS

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**Analizy i Opracowania KEIE UG nr 1/2008**

**Katedra Ekonomiki Integracji Europejskiej UG**

**Ul. Armii Krajowej 119/121**

**81-824 Sopot**

**May 2008**

# Deep determinants of economic growth – empirical verification with panel data models

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## Abstract

We verify the impact of the so-called deep determinants on the level of economic real GDP per capita for an unbalanced panel of 207 economies within the period 1996-2004 using the Hausman-Taylor method of estimation. Institutional variables are detected to be endogenous. The results confirmed the assumed impact of deep determinants on the observed disparities in economic development. In most cases, the underlying specification of the model suggested by the empirical literature (log of openness, the rule of law, distance from the equator) is statistically significant, and the impact of the variables has the anticipated direction. Several other specifications are tested, and they perform pretty well. As the distance from equator has been detected not to be statistically insignificant in several specifications (for Asia and Europe) a combination of exogenous geographical variables enters the model with positive results. The basic specification of the model fits well the context of Africa and South America. It, however, performs badly for Asia. The quality of institutions is of prime importance for southern hemisphere economies as well as for former (currently economies in transition) and current socialist economies. The permanent improvement in the quality of institutions is the key determinant of the success of economic transformation – underperformance in this area leads to smaller gains in terms of GDP per capita levels attained.

Keywords: economic growth, economic development, institutions, geography, openness, panel data models, Hausman-Taylor estimator

JEL: O10, O11

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## 1. Introduction[1]

Identifying the causes of the presently observed large discrepancies in the level of economic development is crucial for providing right policy recommendations and could be considered as one of the most significant issues in economics.

It is worth to note several important facts. The Economic landscape is not homogenous – the overall progress is fueled by rather rare growth poles which most of the time have a permanent nature (path-dependence). Spatial considerations clearly matter for economic growth and economic development. Furthermore, absolute convergence finds empirical support only for structurally homogenous groups of countries. Globalization seems to magnify the initial discrepancies which scale at the pre-industrial phase of development appears to be a minute from our present perspective.

One of the most interesting approaches to determinants of economic growth is their division into shallow and deep determinants. Shallow determinants result from the decomposition of economic growth in standard growth accounting exercise and are endogenous in nature. These are an accumulation of factors of production such as physical and human capital or labor as well as the residual element. The residual is referred to as the so-called Solow residual or Total Factor Productivity (TFP)[2]. Numerous empirical studies devoted to economic growth, for instance, Helpman (2004) or Hulten and Isaksson (2007), indicate that most of the observed discrepancies in GDP per capita levels and event to a greater extent in observed discrepancies in real GDP per capita growth rates are related to the impact of the residual factor[3]. TFP is said to show the impact of the technological process on general productivity but in reality shows all other potential determinants not included in the given specification of the empirical model. From the point of view of economic development, the above results are not satisfactory. – we should not only be able

[1] The present paper has been written within the research grant „Głębokie determinanty wzrostu gospodarczego – weryfikacja empiryczna z wykorzystaniem metod estymacji panelowych", no BW 3480-5-0176-7.

[2] Please refer to analysis of Barro and Sala-i-Martin (2004).

[3] On average the contribution of TFP to explaining economic growth is close to 60 per cent.

to explain the actual nature of the residual element but to empirically determine the truly fundamental determinants of growth.

Rodrik, among others, presents an interesting approach to the problem (Rodrik 2002, 2003). In his works, the point of emphasis shifts from the traditional analysis of shallow determinants to the analysis of principal deep determinants. These deep include geography, integration (openness) and institutions. According to Rodrik, geography understood as a set of factors related to a location on Earth is the only purely exogenous determinant of growth. Institutions and integration have only a semi-endogenous character as they are affected by geography. The usual definition of institutions in the empirical literature is rather broad (for instance refer to Sala-i-Martin (2002). Integration is understood by Rodrik as Tinbergen's negative integration – the extent of liberalization of trade in goods and services as well as factor flows. Integration could be thus understood as a general level of openness of an economy. According to Rodrik, complex linkages exist among the deep and shallow determinants of economic growth. It has to be taken into account in the empirical analysis.

Recent empirical studies seem to support the fundamental role of deep determinants in explaining observed differences in income levels as well as in economic growth rates. For instance, Doppelhoffer et al. (2000) state that variables related to deep determinants of economic growth dominate the group of variables closely related to economic growth.

In the empirical literature, there is, however, no agreement on the significance of particular determinants. Some studies point to the fundamental character of purely exogenous geography (which is outside of the realm of economic policy interventions). At the same time others (for instance Rodrik et al. (2002), argue that the impact of institutions be far greater than that of geography or integration.

The aim of the paper is to verify the impact of deep determinants of economic growth on the level of GDP per capita on a global panel and then to test the robustness of the results on smaller – more homogenous subpanels. The analysis is carried out with the use of panel data techniques.

The rest of the paper is organized as follows. The next section presents results of selected empirical studies on the deep determinants of economic growth. In Section 3, we perform the econometric analysis of the base and extended versions of the empirical model for the global panel and a set of subpanels. Section 4 concludes.

## 2. Empirical studies on deep determinants of economic growth

A large portion of discussion in the empirical literature on deep determinants of economic growth focuses of the domination of one set of determinants over others in other words on the fundamentality of determinants – whether strictly exogenous geography is more fundamental than at least partially endogenous institutions or the degree of openness. The liveliest debate takes place between proponents of institutions versus those supporting the role of geography (Helpman 2004).

For instance Rodrik et al. (2004) state in their cross-sectional study on deep determinants of economic growth that institutional factors are the most fundamental determinants. They assert that traditional geographic variables have at the most weak direct impact on growth if one controls for the impact of institutions (they utilize new instrumental variables for institutions and openness). They emphasize, however, that geography largely determines the quality of institutions and thus indirectly affects growth. Openness seems to have only a weak direct impact on growth. Rodrik et al. (2004) emphasize that discrepancies between results obtained in the empirical literature is to a large extent caused by sample-selection bias, by choice of empirical specification of models as well as by choice of variables depicting deep determinants of economic growth.

Sachs (2003) warns against overrating of the role of broadly defined institutions in explaining economic growth in contrast to other determinants such as geographic factors or resource endowments. Sachs criticizes the simplification of the present debate by saying, that explanation of such a complex process only through institutional factors is attractive though far from reality. Sachs emphasizes, furthermore, that this view could potentially be harmful to LDC as it could decrease aid assigned to LDCs. The causes of their overall poor

performance could be reduced only to institutional deficiencies not taking into account other framework conditions.

Glaeser et al. (2004) are also very critical of the hitherto empirical analysis, which assigns institutions the fundamental role in explaining differences in economic growth rates. To prove them wrong, they once again analyze the causality between growth and quality of institutions. The first area of their critique is the poor quality of proxies for institutions utilized in the empirical literature as well as basic errors, at least in several cases, in empirical estimation using instrumental variables (IV). Simple cross-sectional analysis leads Glaeser et al. (2004) to the conclusion that human capital accumulation plays a dominant role in explaining observed differences in income levels. The role of human capital clearly surpasses the role of institutions. Furthermore, they agree that escaping the poverty trap requires appropriate policy steps – they point out however that paradoxically these policy steps are very often introduced by dictators. Only in the long run, it allows for improvement in the overall quality of institutions.

The study of Gallup et al. (1998) for a large cross-sectional sample of countries shows a positive impact of openness on growth when geographic determinants are controlled for. The authors conclude that geographic factors that increase transaction cost lower the rate of economic growth. It is worth to note, however, that the study of Gallup et al. (1998) does not take into account institutional factors, which is a major disadvantage in the light of the on-going debate.

Dollar and Kraay (2002) note that despite the use of appropriate instrumental variables for trade and quality of institutions empirical literature does not take into account a high degree of correlation between the two. Utilizing a dynamic approach – changes in the rates of growth decade to decade, they show the significance of trade relations (openness_ and only limited impact of shifts in the quality of institutions. Dollar and Kraay (2002) note that the impact of openness on growth is particularly strong in the short run while in the long run both openness and institutions seem to matter.

Hausman et al. (2005) analyze relatively recent events of growth accelerations (defined as a period of minimum eight years of accelerated growth rates). In the sample of 110 economies within the period 1957-1992, they identify 60 economies with at least one event of growth acceleration. They indicate that in most cases the observed acceleration in growth rates was not accompanied by a significant shift in the actual economic policy or in the institutional (political) framework. Furthermore, growth accelerations seem not to depend on external conditions. According to Hausman et al. (2005), they result from idiosyncratic adjustments or are consequences of purely random events. In other words, deep determinants seem not to have played a role in recent growth accelerations.

In their interesting study Falkinger and Grossman (2005) show that among open economies democracies (a proxy for quality of institutions) are likely to obtain a higher growth bonus in the mid and long term. The quality of institution seems to have an impact on the benefits associated with the external liberalization of an economy.

Doppelhofer et al. (2000) utilizing the BACE[4] approach for a large set of variables correlated with economic growth identified a set of those which in 89 million regressions had the highest posterior probability of inclusion in the first growth regression and had a robust and statistically significant impact on the rate of growth. The list of variables strongly or robustly related to growth included among others: the East Asian dummy (+, the sign showing the direction of impact on growth), primary schooling enrollment rate in 1960 (+), the average price of investment goods (-), initial level of GDP per capita (-) indicative of conditional convergence, proportion of land area in tropics (-), density of population in coastal zones (+), malaria prevalence index (-), life expectancy in 1960 as well as a dummy variable for Africa (-). Thus in the group of variables robustly related to growth in the study of Doppelhofer et al. (2000) we can easily identify representatives of three major deep determinants of economic growth. It is, however, worth to note that variables related to geography and institutions clearly dominate.

**3. Empirical analysis for global panel of countries**

[4] Which stands for Bayesian Averaging of Classic Estimates.

Our data set contains observations for 207 countries and nine periods from 1996 to 2004. It gives a total of 1863 observations. The data panel is unbalanced.

The aim of the analysis is to estimate the impact of three major deep determinants of economic growth – geography, institutions, and integration, on the level of economic development. We measure the level of economic development by the natural logarithm of GDP per capita adjusted for purchasing power parity (given in constant USD from 2000) taken from the World Development Indicators 2007 database.

The general structure of the empirical model with time-specific and country-specific fixed effects (two-way panel) is given by the following equation:

$$[1] \qquad \ln GDPpc_{it} = c + b1\,INT_{it} + b2\,INST_{it} + b3\,GEO_i + u_i + \lambda_i + e_{it},$$

with INT – proxy for integration, INST – proxy for institutions, GEO – a vector of proxied for geography, $u_{i,}$ and $\lambda_t$ denote country and time-specific effects.

The lack of log of initial GDP per capita on the LHS means that we are dealing with a static panel model. The general structure of the model reflects the idea behind the paper of Rodrik et al. (2004). The major contrast is the use of a panel data approach instead of traditional cross-sectional analysis.

In line with the benchmark study, we have chosen proxies for the base specification of the model. Natural logarithm of the openness index, the ratio of total trade to GDP, was selected as a proxy for the impact of integration (lnopen) despite some criticism in the empirical literature. The variable is positively correlated with GDP per capita and to a large extent depends on the scale of the economy.

Proxies for the level of institutional development were taken from the famous study of Kaufmann, Kraays and Mastruzzi (Kaufmann et al. 2005) carried out for World Bank. Their institutional quality data set covers 209 countries and territories for 1996, 1998, 2000, 2002 as well as 2004. The authors constructed the aggregate indices based on 352 variables from

37 data sets gathered by 31 different organizations[5]. These source variables were assigned to fundamental groups of quality of institutions with the use of unobserved components model, which allowed them to obtain six aggregate indices of institutional development: voice accountability (voiceacc), political stability (pol_stab)governance effectiveness (goveff), and regulatory quality (regqual), rule of law (roflaw) as well as corruption control (corupcntrl). Each of the aggregated indices has a normal distribution with zero mean and standard deviation equal to one. Higher values of the variable indicate higher governance effectiveness.

Even simple scatterplots clearly point to a statistically significant and positive relationship between the rule of law, regulatory quality and governance effectiveness (variable we have chosen for econometric analysis) and the level of GDP per capita. The simple scatterplots do not allow us however to draw any conclusions on causality – with high level of probability better institutions lead to higher growth rates and thus higher level of income per capita as we could interpret the relation another way around – higher level of income per capita leads to improvement in the quality of the institutions.

As a supplement to the set of institutional variables, we take into account two additional dummy variables. These are dummies for socialist states or those in the process of transformation from socialist to free market economy (socialist) as well as for states with internal or external military conflict (wardum).

The third group of variables contains a set of selected characteristics describing the geographical conditions of countries and territories. They were either taken from the data set of Center for International Development at the Harvard University (CID) or constructed by the authors. These include: distance to equator (disteq)[6] and the share of land area with temperate climate (kgatemp) both with expected positive impact on income per capita as well as those with potentially negative impact: mean elevation (elev, CID), mean distance to

[5] As the institutional variables in the original study were given as point estimates at two years intervals the missing observations were calculated as mean averages of values of variables from preceding and subsequent years.

[6] The value of the variable is equal to the latitude of the capital city divided by 90.

coast (distc), landlockedness (landlock), malaria prevalence (mal94a) – share of total area stricken by malaria in 1994[7].

The database contains as well the following dummy variables: SOUTH – dummy variable for countries located in the southern hemisphere, CAF – Africa, CNA – North America, CSA – South America, CEU – Europe, CAS – Asia, COC – Oceania and Australia as well as a set of time indicator variables (yr*). The standard description of the utilized variables can be found at the end of the paper in Table 1.

***Results of estimation***

The basic specification of the model is in line with the guidelines of Rodrik et al. (2004) and includes only three explanatory variables – proxies for three major deep determinants of economic growth. These are a log of openness ratio (lnopen) – a proxy for integration, the rule of law (roflaw) – a proxy for institutions and distance to the equator (disteq) – a proxy for geography.

We considered both: fixed (FE) and random (RE) individual effects. Verification of estimated models has shown both fixed effects (F test) as well as random effects (Breusch-Pagan test) to be statistically significant. In that case, Hausman test can allow us to choose a more efficient estimation method. Due to the existence of heteroscedasticity in the panel of data (as proven by a modified Wald test for groupwise heteroscedasticity in unbalanced panels), we estimated the FE model with robust errors adjusted for that problem. The differences between FE and RE models have been shown to be of systematic nature and thus were related to false assumptions in the RE model. It implies that despite the fact that the RE estimator could be more efficient it gives biased results. The bias is related the fact that one or two explanatory variables are correlated with the joint error term (composed of purely random disturbance and individual random effects).

The comparative analysis of differences in parameters between the FE and RE models indicated that the discrepancy was the largest in the case of the rule of law. It implies that

[7] Due to their nature the variables disteq, kgatemp and landlock, as well as landlock and distc cannot be included in the same specification of the model.

rule of law is potentially correlated with individual random effects. To test this hypothesis we decomposed the variable into two elements: the mean and the deviation from the mean and then we analyzed the impact of the decomposed variable on the dependent variable. The procedure allowed us to obtain unbiased estimates of the random effects model, as the explanatory variables do not depend on the common random term. We could interpret the fact as a proof of endogeneity of the rule of law in the proposed model.

It is thus worthy to use a model with random effects taking into consideration the endogeneity of the rule of law (roflaw). The appropriate estimation method in this setting is the Hausman-Taylor estimator[8]. Hausman-Taylor estimator (Hausman, Taylor 1981) is applied to panel data models with random effects (*random effects, RE*), in which some of the explanatory variables are correlated with non-observable specific effect. We have a situation in which in the model of the following structure:

$$[2] \qquad y_{it} = \beta_1 x1_{it} + \beta_2 x2_{it} + \gamma_1 z1_i + \gamma_2 z2_i + u_i + e_{it}$$

has the following properties: random individual effects $u_{[i]}$ are correlated with the explanatory variables $x2_{[i,t]}$ and $z2_{[i]}$, but are not correlated with $x1_{[i,t]}$ and $z1_{[i]}$ variables, while z1 and z2 are time invariant, that is, constant within the panel.

The use of the Hausman-Taylor estimator brings several advantages. The estimator is more efficient (RE), the bias related to lack of independence of explanatory variables from the joint disturbance term is eliminated, the problem of heteroscedasticity is eliminated through the use of the general least square method, and there is no question related to correlation of variables constant in time with the fixed effects.

In the empirical analysis, we adopt the following procedure. First of all, we analyze the base specification of the model as well as its modifications on a broad set of countries (global panel). Secondly, to test the robustness of the results the analysis is conducted on sub-samples of the global panel.

[8] Following the same procedure we have proven the endogeneity of goveff and regqual.

The results of the estimation are given in Table 2 at the end of the paper. All specification are estimated with the use of Hausman – Taylor method in line with the general assumptions based on the specific nature of a given panel model.

The first specification is the base specification of our model. It includes the rule of law, a log of openness index and distance to the equator. As expected the impact of variables on GDP per capita levels is positive and statistically significant (at 1 percent level). We obtain a relatively high value of $R^2$ which is calculated as a square of correlation index between observed values of explained variable and theoretical values calculated without the impact of random effects. It is worth to note that random effects are statistically significant in all specifications.

In the next two specifications, we check the robustness of impact of institutions on explained variable by substituting the rule of law with other institutional proxies. In specification S2 it is regqual – giving the quality of the regulatory environment and in S3 - goveff showing governance effectiveness. The positive and statistically significant impact of institutional factors on GDP per capita do not disappear.

Even though we use the method with individual random effects for countries in the next specification (S4), we decide to eliminate the impact of variance in time by adding fixed effects for the time. To do so, we include eight-time dummy variables skipping the first observation in accordance with the methodological principles. The values of the t-Student test next to the dummies prove their statistical significance. It is further proven by the value of the $\chi^2$ test indicating the joint significance of fixed time effects. The impact of deep fundamental determinants of economic growth retains its direction, and statistical significance of coefficient decreased next to log of openness and a significant increase in the coefficient next to the proxy for institutions. The importance of institutions is thus higher than in previous specifications. It is worth to note that the value of the Wald test – verifying the joint significance of random effects, increases significantly.

In the next specification (S5) the suggested proxy for geography – distance to the equator is substituted by a set of four variables: elev, kgatemp, landlock and mal94a. It is accompanied

by a significant increase of $R^2$ to 66,2 per cent. It implies that excluding the impact of random effects, the set of variables explains nearly two-thirds of the variation in GDP per capita levels in the panel. The impact of individual geographic factors is in line with our expectations – mean elevation, landlockedness and malaria prevalence have an adverse impact while the share of land area in a temperate climate has a positive impact on the explained variable. The substitution of distance to the equator with a set of explanatory variables has not decreased the impact of geography on growth.

In the next specification, we extend the model by once again adding a set of time dummies. The $R^2$ increases nearly to 72 percent, and the impact of variables of interest to us on the level of GDP per capita retains its direction.

In specification S7 variable landlock is substituted by the mean distance to coast (distec). It does not affect significantly the coefficients on other variables.

In the last specification, we extend the base specification by adding to the model with time dummies an additional variable affecting institutional quality. It is wardum showing internal and external military conflicts. Its impact, in accordance with our expectations, is negative and significant at 5 percent level.

***Robustness analysis – estimation of subpanels***

In accordance with the adopted procedure in the next step, we verify the robustness of obtained results by estimating models on subpanels. Once again we utilize the Hausman-Taylor estimator. The results are given in Table 3.

The first two specifications divide the global panel into two subpanels of Northern and Southern hemisphere economies – deciding factor be the location of the capital city. In the first case, the impact of proxy for institutional factors on the explained variable (the rule of law) loses its statistical significance. For Southern hemisphere panel, the direction of incidence of all deep determinants of economic growth on the GDP per capita levels is by

our expectations and statistically significant. However, in the case of openness index, it is only at 10 percent level.

Next, we move to testing continental subpanels. Regarding African economies, the impact of institutional proxy is not statistically significant. It is interesting though as apart from several exceptions African economies have the lowest values of institutional quality indices in the study by Kaufmann et al. (2004). It could be so that the variation in the quality indices is too low among African economies to explain the observed discrepancies in the level of development. Referring to the study by Kaufmann et al. (2004). It is important to note that only 7 African states have a positive value of the rule of law. These are Reunion, Mauritius, Botswana, South Africa, Cape Verde and Tunisia. The quality of institutional factors is the lowest in the case of Somalia, Zaire, Liberia, Zimbabwe and Sudan. Furthermore, we have to note that many countries of Africa are stricken by military conflicts which have a significantly negative impact on their institutional framework. It applies in particular to Algeria, Angola, Chad, Eritrea, Ethiopia, Liberia, Mozambique, Namibia, Somalia, Sudan, and Uganda.

The level of openness, as well as the rule of law (institutional variable), retain a highly significant impact on GDP per capita in the model restricted to European countries. It is worth to note that the value of coefficients on these parameters is especially high in comparison to other continental subgroups. The overall good quality of institutions is a leading factor differentiating Europe from other continents. Scandinavian economies, Switzerland, Luxembourg or the Netherlands belong to a group of top world performers. On the other hand, Belarus, as well as most of the CIS and Balkan countries, are clear outliers in Europe.

The impact of geography as proxied by the distance to the equator is not statistically significant in the case of Europe. Distance to the Equator (latitude) to a large extent shows the impact of climate – low values of the index indicate the location in tropical and subtropical zones and high values in the temperate zone – the one which best suites economic performance (Weil 2004). Most of the European states are located in the temperate climate thus small variation in that area has not shown up as a significant factor

in the results. We have to stress, however, that conclusion that geography does not play a role in the development of Europe would be false. Other variables, when they substitute distance to the equator, such as mean elevation or landlockedness, have a statistically significant impact on the level of income per capita in Europe.

In the case of Asia, the base model performs badly. The impact of both institutional, as well as geographic proxies, is not statistically significant, and at the same time, the direction of impact is not in line with our expectations. It is, however, worth to note that introduction of mean elevation or landlockedness in the place of distance to the equator (the results are not given in the text) brings the impact of geography and institution back to normal. Geography matters for Asia. Contrary to Asia the base specification in the case of South America performs well – all coefficients are statistically significant. In particular, the impact of institutional factors on GDP per capita is high.

Finally, in the last two specifications, we divide the global sample into two sub-samples of socialist as well as non-socialist economies. We have to note that the impact of institutional quality on the level of GDP per capita is statistically significant only for the first group. That surprising result could be at least partially related to our definition of the variable. The socialist group of countries takes into account both present socialist economies as well as economies in the transition to free market economy.

We can, however, assert that in this specific group of countries attaining a higher quality of institution allows them to achieve a higher level of income per capita – institutional change is the core of transformation.

## 4. Conclusions

Despite major importance for economic development policies, the empirical literature lacks clear-cut answers to most of the questions related to deep determinants of economic growth and linkages between them. Only some partial answers are available. It is an unfortunate feature of most of the empirical studies devoted to economic growth.

We still have significant problems in measuring institutions and openness (integration). Furthermore, it is hard to disentangle the impact of each of variables from the complex network of linkages between them. Due to gradual changes in the quality of institutions and the level of openness one cannot fully account for it in cross-sectional studies. The panel data approach has an advantage as it has both the cross-sectional and time series dimension.

The econometric analysis for a large panel of data within the period 1996-2004 has pointed to the endogeneity of institutional variables in the analyzed specifications of the base model. We have rejected simple panel models (FE and RE) and utilized more effective random-effects model estimated with the use of Hausman-Taylor estimator.

The obtained results have confirmed the significance of deep determinants of economic growth for explaining observed differences in the level of development. In most cases, the variables in the base specification of the model – reflecting other studies in the empirical literature, had significant impact on the level of income per capita and the direction of impact has been in line with our expectations. We have shown other institutional variables (such as governance effectiveness or regulatory quality)as well as other proxies for geography (including a set of variables simultaneously) could substitute for the standard variables and their impact would remain statistically significant. It is important as in several continental subpanels (Europe and Asia for instance) the impact of the variable suggested by empirical literature – distance to the equator is not statistically significant. It could easily lead to false conclusions. Geography proxied by adequate variables still matters.

In general, we identified a problem of limited robustness of the base specification of the model. The base model performs very well in the global sample as well as in the case of Africa and South America; it underperforms in the case of Asia.

The quality of institutions is particularly significant for countries of the Southern hemisphere as well as the group of transition economies. It seems that to maximize benefits related to economic transition countries have to put emphasis on the permanent improvement in the quality of institutions. A simple analysis shows that countries which made the biggest

improvement in that area were able to rip the greatest benefits regarding income per capita.

Deep determinants of economic growth to a large extent explain the observed discrepancies in the level of development as measured by GDP per capita in PPS. It seems that the deep determinants play a significant role in explaining differences in the speed of convergence and provide reasons for the phenomenon of club convergence – the discrepancies in deep determinants of growth could be judged to be responsible for the existence of the clubs.

An ongoing empirical challenge is to confront the obtained results with long term evidence - the analysis should be repeated on a maximally elongated panel of data – the major bottleneck off course being the availability and quality of data. We should furthermore continue the quest for obtaining more better proxies for institutional quality as well as the degree of openness. We should also employ more efficient estimation techniques. The pursuit of better understanding of determinants of growth has to continue.

## References


Barro R.J., Sala-i-Martin X. (2004*) Economic Growth*, 2nd edition, MIT Press, London.

Dollar D., Kraay A. (2002) *Institutions, Trade, and Growth*, the World Bank.

Doppelhofer G. et al. (2000) *Determinants of Long-term Growth: A Bayesian Averaging of Classical Estimates (BACE) Approach*, NBER Working Paper 7750.

Falkinger J., Grossman V. (2005) Institutions and Development: The Interaction between Trade Regime and Political System, *Journal of Economic Growth*, 10, s. 231–272.

Gallup J.L., Mellinger A., D. Sachs J. D. (1998) *Geography and Economic Development*, conference paper, website.

Glaeser E. et al. (2004) Do Institutions Cause Growth?, *Journal of Economic Growth*, 9, s. 271¬303.

Hausman et al. (2005) Growth Accelerations*, Journal of Economic Growth*, 10, s. 303–329.

Hausman J. A., Taylor W. E. (1981) Panel Data and Unobservable Individual Effects, *Econometric*a, Vol. 49, no. 6, pp. 1377-1398.

Helpman E. (2004) *The Mystery of Economic Growth*, Harvard University Press, Cambridge.

Hulten Ch., Isaksson A. (2007) *Why Development Levels Differ: The Sources of Differentia Economic Growth in a Panel of Rich and Low-Income Countries*, NBER Working Paper no. 13469.

Kaufmann D. et al. (2007) *Governance Matters IV: Governance Indicators for 1996-2004*, Word Bank Paper WPS 3630.

Rodrik D. (2002) *Institutions, Integration and Geography: In Search of the Deep Determinants of Economic Growth*, website.

Rodrik D. (2003) *Growth Strategies*, NBER Working Paper 10050.

Rodrik D. et al. (2004) Institutions Rule: The Primacy of Institutions Over Geography and Integration in Economic Development, *Journal of Economic Growth*, 9, pp. 131-165.

Sachs J. D. (2003) *Institutions Master but Not for Everything, Finance & Development*, website.

Sachs J.. D., Warner A. M. (1995a) *Economic Convergence and Economic Policies*, NBER Working Paper No. 5039.

Sachs J.. D., Warner A. M. (1995b) Economic Reform and the Process of Global Integration, *Brookings Papers on Economic Activity*, no. 1/1995, pp. 1-118.

Sala-i-Martin X. (2002) *15 Years of New Growth Economics: What Have We Learnt?*, Columbia University, Department of Economic Discussion Paper 0102-47.

Weil D. (2005) *Economic Growth*, Addison-Wesley, Boston.

World Bank (2007) *World Development Indicators*, New York.

**Table 1 Description of utilized variables**

| Variable | Description | No of observations | Mean Std Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| **lngdppc** | log of GDP per capita in PPP | 1506 | 8.466436 1.13739 | 6.13 | 10.86 |
| **lnopen** | log of openness index | 1554 | 4.333586 .5443903 | 0.43 | 6.07 |
| **roflaw** | Rule of law | 1679 | -.0055807 .9948102 | -2.31 | 2.36 |
| **regqual** | Regulatory quality | 1703 | -.0018262 .9864024 | -3.99 | 2.58 |
| **goveff** | Governance effectiveness | 1707 | -.0017955 .9931633 | -2.59 | 2.59 |
| **elev** | Mean elevation | 1476 | 605.1021 558.1013 | 0 | 3185.92 |
| **distc** | Mean distance to coast | 1476 | 388.0074 453.0118 | 0 | 2374.23 |
| **kgatemp** | Share of total area in temperate climate | 1476 | .2867352 .4122114 | 0 | 1 |
| **landlock** | Landlockedness | 1863 | .1835749 .3872411 | 0 | 1 |
| **mal94a** | Malaria prevalence in 1994 | 1467 | .3708397 .4318294 | 0 | 1 |
| **wardum** | War dummy | 1476 | .1890244 .3916607 | 0 | 1 |
| **disteq** | Distance to equator | 1863 | .2765727 .1840793 | 0 | .712963 |
| **socialist** | Socialist | 1863 | .2222222 .4158513 | 0 | 1 |
| **caf** | Africa | 1863 | .2657005 .4418241 | 0 | 1 |
| **csa** | South America | 1863 | .0628019 .2426715 | 0 | 1 |
| **cna** | North America | 1863 | .1497585 .3569303 | 0 | 1 |
| **ceu** | Europe | 1863 | .2028986 .4022656 | 0 | 1 |
| **cas** | Asia | 1863 | .2463768 .4310162 | 0 | 1 |
| **coc** | Australia and Oceania | 1863 | .0724638 .2593239 | 0 | 1 |

*Source: Own calculations.*

**Table 1 Hausman-Taylor estimates of the baseline model for the global panel of countries and territories**

| | S1 | S2 | S3 | S4 |
|---|---|---|---|---|
| **lnopen** | .2404 | .2432 | .2557 | .1023 |
| | 13.13[.000]*** | 13.43[.000]*** | 14.14[.000]*** | 6.29[.000]*** |
| **roflaw** | .0261 | | | .0852 |
| | 1.98[.048]** | | | 7.66[.000]*** |
| **regqual** | | .0523 | | |
| | | 5.71[.000]*** | | |
| **goveff** | | | .08670 | |
| | | | 7.26[.000]*** | |
| **disteq** | 3.2019 | 3.1846 | 3.0518 | 3.1147 |
| | 8.37[.000]*** | 8.66[.000]*** | 8.49[.000]*** | 8.40[.000]*** |
| **cons** | 6.4950 | 6.4824 | 6.4676 | 7.0442 |
| | 42.45[.000]*** | 43.62[.000]*** | 44.47[.000]*** | 48.65[.000]*** |
| **yr1** | | | | - |
| | | | | - |
| **yr2** | | | | .01862 |
| | | | | 2.29[.022]** |
| **yr3** | | | | .03599 |
| | | | | 4.49[.000]*** |
| **yr4** | | | | .0509 |
| | | | | 6.34[.000]*** |
| **yr5** | | | | .0666 |
| | | | | 8.14[.000]*** |
| **yr6** | | | | .0871 |
| | | | | 10.70[.000]*** |
| **yr7** | | | | .1057 |
| | | | | 12.94[.000]*** |
| **yr8** | | | | .1318 |
| | | | | 15.88[.000]*** |
| **yr9** | | | | .1673 |
| | | | | 19.54[.000]*** |
| **n** | 1418 | 1446 | 1446 | 1418 |
| **No of countries** | 166 | 166 | 166 | 166 |
| **Wald chi** | 247.57 | 290.10 | 317.42 | 952.18 |
| **rho** | 0.9916 | .9909 | .9906 | .9940 |
| **$R^2$** | 0.3935 | 0.4069 | 0.4406 | 0.4378 |
| $\chi^2$ | - | - | - | 604.46 |

**Table 2 continued**

| | S5 | S6 | S7 | S8 |
|---|---|---|---|---|
| **lnopen** | .2385 | .0808 | .0777 | .0818 |
| | 12.39[.000]*** | 4.84[.000]*** | 4.66[.000]*** | 4.88[.000]*** |
| **roflaw** | .01646 | .1259 | .1258 | .1273 |
| | 1.08[.279] | 9.70[.000]*** | 9.69[.000]*** | 9.82[.000]*** |
| **disteq** | | | | 3.1454 |
| | | | | 8.57[.000]*** |
| **elev** | -.0003 | -.0003 | -.0003 | |
| | -2.45[.014]** | -2.79[.005]*** | -3.23[.001]*** | |

| | S5 | S6 | S7 | S8 |
|---|---|---|---|---|
| **kgatemp** | .7401<br>4.09[.000]*** | .6488<br>3.94[.000]*** | .5762<br>3.42[.001]*** | |
| **landlock** | -.6336<br>-4.25[.000]*** | -.5877<br>-4.30[.000]*** | | |
| **distc** | | | -.0005<br>-3.84[.000]*** | |
| **mal94a** | -1.3656<br>-7.95[.000]*** | -1.3090<br>-8.42[.000]*** | -1.3509<br>-8.54[.000]*** | |
| **wardum** | | | | -.4486<br>-2.42[.016]** |
| **cons** | 8.0087<br>46.14[.000]*** | 8.7955<br>56.54[.000]*** | 8.8940<br>54.85[.000]*** | |
| **yr1** | | -.1820<br>-20.50[.000]*** | -.1440<br>-16.82[.000]*** | |
| **yr2** | | -.1631<br>-18.51[.000]*** | -.1250<br>-14.67[.000]*** | .01885<br>2.30[.021]*** |
| **yr3** | | -.1526<br>-17.32[.000]*** | -.1145<br>-13.42[.000]*** | .02927<br>3.58[.000]*** |
| **yr4** | | -.1369<br>-15.57[.000]*** | -.0989<br>-11.61[.000]*** | .04494<br>5.49[.000]*** |
| **yr5** | | -.1179<br>-13.89[.000]*** | -.0796<br>-9.54[.000]*** | .06388<br>7.64[.000]*** |
| **yr6** | | -.09103<br>-10.83[.000]*** | -.0528<br>-6.39[.000]*** | .0909<br>10.90[.000]*** |
| **yr7** | | -.06699<br>-8.00[.000]*** | -.0288<br>-3.49[.000]*** | .1150<br>13.68[.000]*** |
| **yr8** | | -.03832<br>-4.62[.000]*** | | .1437<br>16.78[.000]*** |
| **yr9** | | | .0385<br>4.64[.000]*** | .181971<br>20.49[.000]*** |
| **n** | 1301 | 1301 | 1301 | 1301 |
| **No of countries** | 148 | 148 | 148 | 148 |
| **Wald chi** | 427.24 | 1236.45 | 1226.49 | 1025.64 |
| **rho** | .9846 | 0.9883 | 0.9940 | .9934 |
| **$R^2$** | 0.6620 | 0.7193 | 0.7113 | 0.5122 |
| $\chi^2$ | - | 668.34 | 672.05 | .. |

*Source: Own calculations. Estimation carried out in STATA version 10.*

Comments:

a) Hausman-Taylor estimator (RE)
b) Dependent variable – log of GDP per capita in PPP (in constant USD from 2000)
c) A total number of observations (n).
d) Significance levels - *** 1 per cent ., ** 5 per cent, * 10 per cent.
e) t-Student statistics under coefficients .
f) [ ] Prob values for verification tests.
g) Wald test - verifies significance of specification in RE model
h) Rho – indicates what part of the variance of explained variable is explained by variance in random effects
i) R^2– calculated as a square of correlation index between empirical values of explained variable and theoretical values calculated without the impact of random effects
j) $\chi^2$ test – value of the test for the joint significance of time dummies yr1 – yr9.

**Table 3 Hausman-Taylor estimates for various sub panels**

| | Northern hemisphere | Southern hemisphere | Africa | Europe | Asia | South America | Non-socialist | Socialist |
|---|---|---|---|---|---|---|---|---|
| **lnopen** | .3414 | .0473 | .1157 | .5982 | .3723 | .0590 | .1347 | .3899 |
| | 14.68[.000]*** | 1.87[.061]* | 4.64[.000]*** | 11.22[.000]*** | 8.58[.000]*** | 1.84[.066]* | 7.22[.000]*** | 9.27[.000]*** |
| **roflaw** | .0040 | .0983 | .0119 | .1496 | -.0399 | .1453 | -.0116 | .1082 |
| | 0.24[.809] | 5.22[.000]*** | 0.65[.515] | 3.90[.000]*** | -1.03[.302] | 5.60[.000]*** | -0.97[.330] | 2.60[.009]** |
| **disteq** | 3.0982 | 4.0349 | 3.0044 | 1.2468 | -.9382 | 1.6442 | 4.5897 | 3.0043 |
| | 7.13[.000]*** | 3.57[.000]*** | 2.97[.003]*** | 0.81[.419] | -0.74[.457] | 2.19[.028]** | 10.36[.000]*** | 5.17[.000]** |
| **cons** | 6.085 | 7.1842 | 6.5463 | 6.0456 | 7.1191 | 8.1214 | 6.8455 | 5.1911 |
| | 32.03[.000]*** | 26.62[.000]*** | 30.83[.000]*** | 6.83[.000]*** | 14.63[.000]*** | 37.89[.000]*** | 43.96[.000]*** | 16.03[.000]*** |
| **n** | 1107 | 311 | 429 | 324 | 340 | 108 | 1071 | 347 |
| **No of countries** | 129 | 37 | 50 | 36 | 40 | 12 | 127 | 39 |
| **Wald chi** | 271.12 | 47.26 | 31.53 | 141.87 | 90.75 | 38.48 | 162.11 | 138.08 |
| **rho** | .9917 | .9935 | .9903 | .9844 | .9920 | .9821 | .9939 | .9645 |

*Source: Own calculations. Estimation carried out in STATA version 10.*

Comments:

a) Hausman-Taylor estimator (RE)
b) Dependent variable – log of GDP per capita in PPP (in constant USD from 2000)
c) A total number of observations (n).
d) Significance levels - *** 1 per cent ., ** 5 per cent, * 10 per cent.
e) t-Student statistics under coefficients .
f) [ ] Prob values for verification tests.
g) Wald test - verifies significance of specification in RE model
h) Rho – indicates what variance explains part of the variance of explained variable in random effects
i) R^2– calculated as a square of correlation index between empirical values of explained variable and theoretical values calculated without the impact of random effects
j) $\chi^2$ test – value of the test for the joint significance of time dummies yr1 – yr9.


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